

A NEW SPECIES OF *DICHRORAMPHA* (LEPIDOPTERA: TORTRICIDAE:
GRAPHOLITINI) FROM JAMAICA: A POTENTIAL BIOCONTROL AGENT
AGAINST *CHROMOLAENA ODORATA* (ASTERACEAE)

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Abstract.—*Dichrorampha odorata* Brown and Zachariades, new species, is described and illustrated from Jamaica. It is most similar to *D. sapodilla* Heppner among described species, both superficially and in the male genitalia. However, the two are easily separated by the long costal fold of the male forewing of *D. odorata*, which is absent in *D. sapodilla*. The shapes of the valva and cucullus also distinguish the two. The related *D. azteca* Walsingham, revised status, which shares a distinct male forewing costal fold with *D. odorata*, is returned to *Dichrorampha*. *Dichrorampha odorata* induces galls in the shoot tips of the invasive weed *Chromolaena odorata* (L.) R. M. King & H. Robinson (Asteraceae), commonly known as triffid, Jack-in-the-bush, bitter bush, Christmas bush, and Siam weed. The new species appears to have considerable potential as a biological control agent against this weedy shrub in South Africa.

Key Words: Systematics, Tortricidae, *Dichrorampha*, new species, biological control, triffid, Jack-in-the-bush, *Chromolaena odorata*, Jamaica, South Africa

With over a dozen common names, including triffid, Jack-in-the-bush, Siam weed, bitter bush, and Christmas bush, *Chromolaena odorata* (L.) R. M. King & H. Robinson (Asteraceae) (formerly known as *Eupatorium odoratum* L.) is a perennial shrub native to South and Central America (Holm et al. 1977). In recent decades it has become a serious pest in the humid tropics of southeastern Asia, Africa, and the Pacific Islands. It has been nominated as among the top 100 “world’s worst” invaders (Wilson 2006). It spreads rapidly in lands used for forestry, pasture, and plantation crops such as rubber, coffee, coconut, cocoa, and cashew, owing

to its efficient short- and long-distance dispersal abilities (Muniappan 2005). In South Africa it is a problem primarily for biodiversity conservation, grazing, and forestry (Goodall and Erasmus 1996). Invasive populations of *C. odorata* in Asia and southern Africa both originated from the Caribbean, although the southern African form (biotype) of *C. odorata* is distinct from that invading southeastern Asia and western Africa (Zachariades et al. 2004). Plants identical to the South African biotype have been found only on islands in the northern Caribbean, most notably Jamaica and Cuba (Zachariades et al. 2004).

During efforts to identify biological control agents against this weed, a new species of tortricid moth was discovered in Jamaica that induces galls in the terminal shoots of the plant. The purposes of this paper are to describe and illustrate this new species and present information on its biology.

MATERIALS AND METHODS

Specimens of larvae were discovered in galls of *Chromolaena odorata* in three general areas in Jamaica by personnel from the Plant Protection Research Institute, South African Agricultural Research Council: (1) near Mandeville, (2) in the Blue Mountains, and (3) along the north coast from Port Maria to southwest of Montego Bay. The galls were imported into quarantine in South Africa and successfully cultured (see Biology below). Representative larvae and pupae were placed in boiling water for approximately 2 minutes and transferred to 90% EtOH for preservation. Dissection methodology follows that presented in J. Brown and Powell (1991, 2000). The image of the adult was captured using a Microptics® digital camera system. Preliminary illustrations of the genitalia were drawn from slide-mounted preparations using a Ken-a-Vision microprojector; final illustrations were inked using dissecting and compound microscopes. Terminology for genitalia structures and wing venation follows Horak (1984); terminology for larval chaetotaxy follows R. Brown (1987); terminology for forewing pattern follows R. Brown and Powell (1991), as modified by Baixeras (2002); and plant taxonomy follows GRIN (2006) and METAFRO (2006).

SYSTEMATICS

Dichrorampha, with 112 described species worldwide (Brown 2005), is primarily Palaearctic (ca. 80 species), with 20 described species in North

America, 10 in the Neotropics, and one in South Africa. The new species is assigned to the genus on the basis of the following character states: male forewing with a well developed costal fold (present or absent in *Dichrorampha*, but absent in all other New World Grapholitini) (Heinrich 1926); a distinct row of dark dots along the termen of the forewing (Komai 1999) (Fig. 1); female genitalia with the sterigma, seventh sternite, and sclerotized posterior portion of ductus bursae fused (Komai 1999) (Fig. 3); and female genitalia with a single thornlike signum (usually with two thornlike signa in other genera of Grapholitini) (Heinrich 1926) (Fig. 3). Most species of *Dichrorampha* for which host plants are known (i.e., about 25 species) feed on Asteraceae (e.g., McDunnough 1946; Swatschek 1958; MacKay 1959; Danilevsky and Kuznetsov 1968; Bradley et al. 1979; Jensen and Palm 1981; Park 1983; Godfrey et al. 1987; Sterling 1991; Corley 1992) with a few notable exceptions: *Dichrorampha okui* Komai has been reported from acorns of *Quercus* sp. (Fagaceae) (Oh et al. 2001); *Dichrorampha petiverella* (Linnaeus) (reported as *dorsana*) from *Lathyrus* sp. and *Pisum* sp. (Fabaceae) (Disque 1908; Bradley et al. 1979); and *Dichrorampha manilkara* Heppner and *D. sapidilla* Heppner from *Manilkara* sp. (Sapotaceae) (Heppner 1981). Five of the six species reported from Europe by Swatschek (1958) feed in the roots of their asteraceous hosts, with the sixth feeding on shoots.

Dichrorampha odorata Brown and Zachariades, new species (Figs. 1–9)

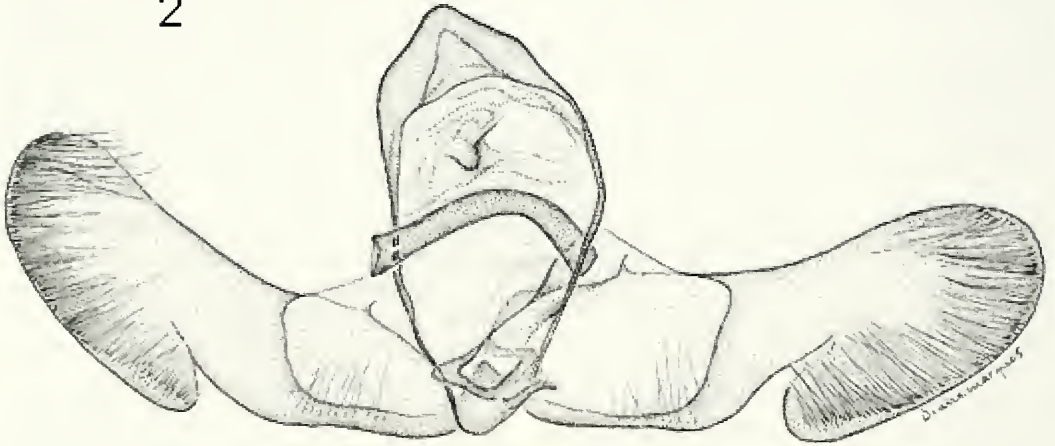
Diagnosis.—*Dichrorampha odorata* is most similar to *D. sapidilla* Heppner (TL: USA, Florida), both superficially and in the male genitalia. However, the two are easily separated by the long

1



— 5 mm —

2



Figs. 1-2 *Dichrorampha odorata*. 1, Adult male (with scale bar), 2, Male genitalia.

costal fold of the male forewing of *D. odorata*, which is absent in *D. sapodilla*. The shape of the cucullus is also distinctive between the two: in *D. sapodilla* it has distinct dorsal and basal lobes and is well separated from the basal part of the valva by a rounded excavation along the venter of the valva; in *D. odorata* the cucullus lacks the dorsal lobe and is separated from the basal part of the valva by a narrow incision along the

venter (Fig. 2). Also, *D. sapodilla* has been reared only from *Manilkara zapota* (L.) P. Royen (Sapotaceae) (Heppner 1981), whereas the new species is known only from *Chromolaena odorata* (Asteraceae).

Dichrorampha odorata is superficially similar to *D. azteca* Walsingham, revised status (TL: Mexico, Guerrero), particularly in the shared possession of a well-developed costal fold in the male fore-



Fig. 3. *Dichrorampha odorata*, female genitalia.

wing. However, the male genitalia of *D. azteca* have a relatively broad, deep, U-shaped excavation immediately basad of the cucullus as in *D. saporidilla* and unlike that of *D. odorata*.

The female of *D. odorata* has a frenulum comprised of two bristles. Although somewhat unusual, this character state is found in several other Grapholitini (e.g., a few species in each of the genera *Pammene*, *Cydia*, and *Grapholita*). Komai (1999) proposed that it represented a synapomorphy for *Strophedra* Herrich-

Schäffer and *Andrioplecta* Obraztsov, but it is considerably more widespread and variable within the tribe (Brown and Baixeras 2006).

Description.—Adult: *Head*: Vertex rough-scaled, cream and pale tan, scales extending forward nearly to middle of labial palpus; frons pale tan; outer surface of labial palpus cream in basal half with small dark spot at base, blackish gray in distal half, with scaling broadly expanded, inner surface cream; antenna pale gray; ocellus present. *Thorax*: Dorsum brown, mixed with pale scales posteriorly, without posterior crest; legs striped cream and gray-brown, male without conspicuous secondary sex scales. Forewing (Fig. 1) ground color mottled gray-brown, brown, and ochreous; termen with distinct subapical indentation between R_5 and M_1 at base of apical-most, white, terminal strigula; a pair of parallel, narrow, brown, oblique fasciae, arising between costal strigulae 7–8 and 9 (i.e., subterminal fascia) and 5–6 and 7–8 (i.e., postmedian fascia), narrowly bordered by pale orange and separated by narrow black line, originating at costa ca. 0.5 and 0.7 distance from base to apex, extending toward termen; costa with 7 pairs of pale strigulae, basal pairs indistinct, distal pairs frequently coalesced; basal half of wing with ill-defined, dark, oblique band, originating at dorsal margin ca. 0.33 distance from base to tornus, attenuating before reaching mid-costa; ocellus (patch) not developed; 3–4 small black spots forming line parallel to termen in yellow-speckled terminal region; interfacial spot ill-defined, mostly obscured with gray-brown. Fringe grayish brown. Ventral surface lustrous bronze. Hindwing uniform dark brown above, except broad area of overlap with forewing whitish. Fringe grayish brown. Ventral surface lustrous bronze. Male frenulum with one bristle, female frenulum with two. *Abdomen*: Scaling dark

brown, without conspicuous secondary sex scaling in male. Male genitalia (Fig. 2; based on 2 preparations) with tegumen rather broad, rounded-triangular dorsally, with small mid-dorsal hump; gnathos a narrow, ill-defined band dorsad of aedeagus; vinculum weakly sclerotized; valva moderately broad, with large, subrectangular basal excavation, costa weakly arched from ca. base to ca. middle of cucullus, apex rounded; sacculus not developed; cucullus broad with large reflexed basal lobe, densely setose, separated from basal portion of valva along ventral edge by deep, narrow incision; "neck" of valva inconspicuous owing to narrow incision; aedeagus relatively long, ca. 0.5 length of valva, arched, slightly dilated distally, with diffuse patch of fixed cornuti. Female genitalia (Fig. 3; 2 preparations) with papillae anales slender, slightly broader in distal 0.5; apophyses posteriores ca. 0.75 times length of apophyses anteriores; sterigma symmetrical, unsclerotized except for narrow crescent-shaped patches extending from lateral edge of rounded, sclerotized ostium; ductus bursae comparatively broad, ca. 8 times longer than wide, distal two-fifths more sclerotized, slightly elongate funnel-shaped, remainder of ductus bursae membranous; ductus seminalis from ductus bursae ca. 0.6 distance from ostium to junction of ductus and corpus bursae; corpus bursae oblong, membranous, with a single, slender, thornlike signum at right lateral side of corpus.

Larva: General (last instar): Length 6.0–7.0 mm ($n = 3$), head somewhat circular in outline in dorsal view, amber to pale yellow with variably developed brown stemmatal patch and spot at genal angle; prothoracic shield pale yellow with faint or no traces of pattern; body pale, pinacula weakly pigmented, inconspicuous; anal shield very pale yellow, unmarked. Thoracic chaetotaxy typically tortricoid, with L-group trisetose on T1

and SV-group 2:1:1 on T1–3. Abdomen with spiracles small and circular, only slightly smaller than that of T1; spiracle on A8 slightly posterior to middle of segment; segments 1–8 with SD2 inconspicuous, SD1 dorsad of spiracle on A1–7, anteriorad of spiracle on A8; L1 and L2 on same pinaculum on A1–8; D2s on shared dorsal pinaculum on A9; D1 and SD1 on a shared pinaculum on A9; L-group trisetose on A9; V's about the same distance apart on A7–9, or slightly further apart on A9; SV Group on 1, 2, 7, 8, 9 is 2:2:2:2:1. Crochets uniordinal, 18–20 on prolegs (A3–6), 10–14 on A10. Anal fork present.

According to Swatschek (1958), the larvae of *Dichrorampha* are characterized by the following: seta SD1 on A8 immediately anterior of the spiracle and SV group bisetose on A1, 2, 7, and 8, and unisetose on A9, except occasionally trisetose on A2. The only species of *Dichrorampha* treated by MacKay (1959) (i.e., *D. bittana*) was reported to lack an anal fork; Swatschek (1958) did not mention this feature is his key or diagnoses of larval *Dichrorampha*.

Pupa: Fusiform, length ca. 5 mm, width ca. 1 mm ($n = 5$); typically tortricoid, without cephalic projection or conspicuous sculpturing. Dorsum of segment A1 lacking spines; dorsum of A2–8 with two rows of spines, anterior row situated at anterior edge of segment, with larger spines, row attenuate well before spiracle; posterior row situated at posterior edge of segment, with smaller spines but frequently extending further laterad; segment A8 sometimes with posterior row weak or absent. Segments A9–10 each with short row of larger thorns; A10 with 6 slender, hook-tipped setae; cremaster absent.

Holotype.—Male, Jamaica, Jackson Town, WP 042, 18.25N, 77.29W, 13 Nov 1999, C. Zachariades. Deposited in Institute of Jamaica, Kingston, Jamaica.

Paratypes.—1 ♂, 10 ♀. Jamaica: Blue Mountains, WP 032-5, 047-051, 18.03N, 76.45W to 18.01N, 76.40W, 9, 10, 14 Nov 1999 (2 ♀), C. Zachariades. Blue Mountains; north along coast from Port Maria to southwest of Montego Bay, 18°01.959–18°27.630N, 78°42.048–78°01.423W, 29–846 m, 16–24 Nov 2005 (1 ♂, 8 ♀), C. Zachariades & L. D. Khumalo. Deposited in the South African National Collection of Insects, Pretoria, South Africa; the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; and The Natural History Museum, London, England.

Distribution.—Known from Jamaica and Cuba.

Etymology.—The specific epithet is derived from the species name of the larval host plant.

Remarks.—The paratypes were collected over a range of localities (i.e., “waypoints J05-008, 009, 010, 011, 013, 014, 016, 017, 018, 019, 029, 021, 022, 025, 026”); hence the precise locality of each individual is unknown. The male holotype, although not the best specimen, was selected because it has more precise locality data.

Dichrorampha azteca Walsingham,
revised status

Dichrorampha azteca Walsingham 1914: 258.

“*Dichrorampha*” [misplaced] *azteca*: Powell et al. 1995: 157.

“Grapholitini Unplaced Species” *azteca*: Brown 2005: 365.

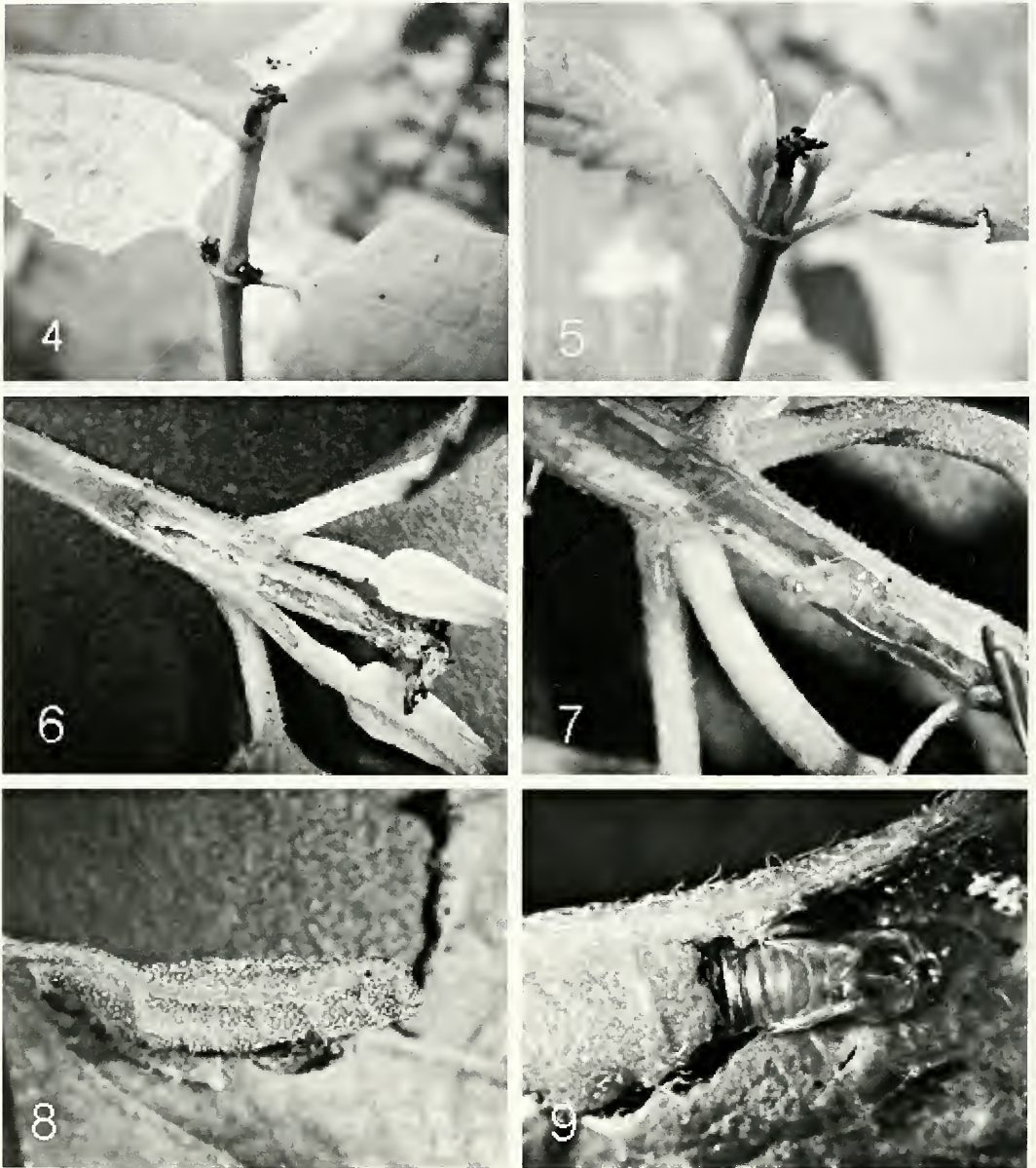
Based on features of the male genitalia and forewing pattern, *D. azteca* is undoubtedly congeneric with *D. odorata* and *D. sapidilla*. It can be separated from those species by the features discussed above in the diagnosis of *D. odorata*. Although described in *Dichrorampha*, *azteca* was treated as “*Dichrorampha*” [misplaced] by Powell et al. (1995), and this treatment was followed

by Brown (2005), who placed it in “Grapholitini Unplaced Species.” However, an examination of the syntype male (The Natural History Museum, London) revealed that it is appropriately assigned to *Dichrorampha* based on its similarity with *D. odorata* and *D. sapidilla*.

BIOLOGY AND DISCUSSION

During field surveys for biological control agents against *Chromolaena odorata*, *Dichrorampha odorata* was collected in Jamaica and Cuba, but only in small numbers. However, in November 2005 large numbers of galled shoot tips were discovered on *Chromolaena odorata* in Jamaica, and a large percentage of the galls contained larvae of *Dichrorampha odorata*. These galls were imported into quarantine in South Africa and successfully cultured.

The damage caused by *Dichrorampha odorata* is superficially similar to that caused by *Phestinia costella* (Hampson) (Lepidoptera: Pyralidae: Phycitinae), also on *C. odorata*, but less frass is produced, the eggs probably are laid in the shoot tip, and the larvae bore into the shoot tip causing the terminal 15–20 mm of the stem to swell slightly and often turn yellow. The terminal shoot tip dies, and the stem ceases its growth. The swollen stems (loosely interpreted as “galls”) induced by *Dichrorampha odorata* are smaller and less obvious than those induced by *Phestinia* species, but growth of the terminal shoot is effectively stopped (Figs. 4–5). In the field, galls of *D. odorata* were found only on terminal shoots whereas those of *Phestinia* were found in axillary shoots as well. Axillary buds are attacked by *Dichrorampha odorata* in the laboratory probably owing to a shortage of oviposition sites. Larvae (Figs. 6–7) bore down the stem for a distance of 15 to 20 mm ($\bar{x} \pm 1$ SD = 18.6 \pm 3.47 mm for n = 11 vacated galls or galls containing mature larvae) and are easily transferred be-



Figs. 4-9. Biology of *Dichrorampha odorata*. 4, Point of entrance of *D. odorata* larvae at shoot tip and axillary buds of *Chromolaena odorata*; 5, Damage to shoot tip of *Chromolaena odorata*; 6, Stem of *Chromolaena odorata* revealing internal damage; 7, Larva of *D. odorata* within stem of *Chromolaena odorata*; 8, Pupal shelter of *D. odorata* on leaf of *Chromolaena odorata*; 9, Pupal exuvium extruded from leaf shelter.

tween plants. When ready to pupate the larva exits the gall and cuts a semicircle in a leaf, folds it over, and attaches its edge back to the leaf with silk to create a shelter (Fig. 8). Prior to emergence the

pupal case is extruded beyond the shelter (Fig. 9). Adults tend to walk rapidly (scuttle) along stems and over leaves of the plant. They have been induced to mate in standard cages (50 × 50 ×

100 cm). Thus far the species has been bred easily and quickly (generation time of 6–7 weeks) in these cages, showing a fairly high rate of increase (the highest was a six-fold increase from one generation to the next).

Larval no-choice tests have been initiated, similar to those conducted by Cruttwell (1977) on insects identified as *Mescinia* nr. *parvula* (Zeller) from Trinidad, but which likely are *Phestinia costella* (A. Solis, personal communication). These tests are considered appropriate because the larvae are highly mobile and are unlikely to bore into plants that they find unsuitable as hosts. In initial tests, mid-instar larvae were placed on marked shoot tips of 10 species of Asteraceae as well as *C. odorata*. Asteraceae were targeted because this family includes the most commonly documented hosts of *Dichrorampha*. Larvae caused galls on only two species (*Mikania capensis* DC. and *Ageratum conyzoides* L.) other than *C. odorata*, but galling was minimal, and none of the larvae on these plants pupated. None of the eight other Asteraceae species offered to larvae (i.e., *Adenostemma cafferum* DC., *Ageratina adenophora* (Sprengel) King & Robinson, *A. riparia* (Regel) King & Robinson, *Synphyotrichum novibelgii* (L.) G. L. Nesom, *Chrysanthemum × morifolium* Ramat., *Delairea odorata* Lem., *Distephanus angulifolius* (DC.) Robinson & B. Khan., *Microglossa mespilifolia* (DC.) Robinson) was fed upon to any degree. The insect thus seems highly host specific.

Provided that it has a host range restricted to *C. odorata*, *Dichrorampha odorata* has several attributes that make it a promising biocontrol agent for this weed in South Africa. It is bred easily under caged conditions, making it a good species for mass-rearing for release. It has a short life cycle and high fecundity, and therefore is likely to increase and spread quite rapidly in the field. Two

leaf-feeding agents, *Pareuchaetes insulata* (Walker) (Lepidoptera: Arctiidae) and *Calycomyza eupatorivora* Spencer (Diptera: Agromyzidae), already are established in South Africa. A stem-tip attacker has long been considered an important element in any successful biological control program against *C. odorata*, both to decrease the extremely high growth rate of the stems and to decrease the number of shoot tips available for flowering (in the laboratory, *D. odorata* larvae also bored into flower buds). Although several other stem-tip attackers are known, many have proven difficult to rear under laboratory conditions. In addition, poor compatibility between the southern African *C. odorata* biotype and insects or pathogens collected from other morphological forms of *C. odorata* in South or Central America frequently has been observed or suspected (Zachariades et al. 2004). This should not be a problem with *D. odorata* because the biotype of *C. odorata* invading southern Africa is believed to have originated in Jamaica or Cuba. When released in the field in South Africa, the ultimate distribution of *D. odorata* may be confined to the coastal belt and other areas with a less severe dry season. In certain inland areas (e.g., Zululand) *C. odorata* dies back during winter, losing its leaves and sometimes its upper stems; fire is also a common occurrence in these areas. The two established leaf-feeding agents, neither of which has a prominent diapause mechanism, currently are restricted to the coastal belt. *Dichrorampha odorata* does not have an obvious diapause, but may achieve a somewhat wider distribution than *P. insulata* and *C. eupatorivora* because it does not rely on leaves for its biology to the same degree as these two species.

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